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published, and dwell with laudable earnestness upon the confusion resulting from carelessness and from opinions based upon inadequate investigation. The great variability of the *Ostreidæ* is emphasized, but the authors correct the opinion previously held that this variability destroys their value in stratigraphy. They show that the hemeræ of many forms have well defined limits and are, therefore, of the greatest use in determining horizons. No classification yet given is satisfactory for the Texas *Ostreidæ*. The forms are tabulated provisionally under the old familiar names.

After this discussion, which deals in some measure with the family in general, the authors confine their attention to the specific object of the paper. The various forms which have been referred to *Gryphæa bitcheri* are discussed from a historical standpoint and their stratigraphic and geographic distribution noted. The species of the group are specifically defined and many data given regarding their development and methods of growth, and lastly, something of their phylogeny. A large part of the bulletin is taken up with plates showing the various species at different stages of growth and the individual shells in different positions. The figures formerly published are also reproduced for comparison. The work is especially commendable for careful investigation and clear-cut presentation.

W. T. LEE.

Le Granit des Pyrénées et ses phénomènes de contact—Premier memoir: Les contacts de la Haute-Ariège, par M. A. LACROIX, Professeur de Minéralogie au Mus. d'Hist. Nat. Bull. des serv. de la carte géol. de la France. No. 64, tome X. Paris, 1898.

The area which has furnished the results published by M. Lacroix in this bulletin is situated in the very mountainous southern tract of the Departement of the Ariège, about 100^{km} southeast by south of the city of Toulouse. The Ariège, one of the head waters of the Garonne, flows through the region. Most emphasis is laid on the phenomena of contact exhibited on the right bank of the stream, since the exposures are considerably more accessible and continuous than on the left bank. The facts of observation on both banks are, however, accordant.

This, the first memoir on the granite massifs of the Pyrénées, is devoted to a purely mineralogical treatment of igneous contacts, which

of itself cannot fail to impress the reader with a sense of the abundant store of facts from which M. Lacroix has drawn his interesting and even startling conclusions. These refer to the prime topics of exomorphic and endomorphic metamorphism and the *mise en place* of the granite, on all three of which the investigations of M. Lacroix shed new light.

The granite occurs in the form of a broad stock stretching some 50^{km} from east to west, and the bulletin refers particularly to the contacts at the western end. The rock is a normal coarse-grained granitite, sometimes, though never at the contacts, charged with phenocrysts of microcline several centimeters long. At the contacts it is filled with an extraordinary number of inclusions of the country rocks.

The latter are composed of slates and quartzites with non-magnesian limestones, either massive or interrupted with interbedded slaty layers. All of these rocks have been affected, often profoundly, by contact metamorphism. To this cause is to be attributed the development of a micaceous character, with garnet, cordierite, and sillimanite common in the contact belt. But the most important determination of this new crystallization is that of the existence of orthoclase and of the triclinic feldspars in the micaceous slate zone (*leptynolites*) in amounts which make the feldspar, either the predominant constituent or less abundant, even to its appearing only as scattering grains. This feldspathization has occurred by the process of "imbibition" or by the injection of minute granite apophyses *lit par lit*. The quartzites are similarly feldspathized and rendered micaceous, though in less marked degree than the slates. The white and black limestones, on the other hand, are much more affected, containing grossularite (*grenatite*), vesuvianite, various pyroxenes and amphiboles, epidote (*epidotite*), and the triclinic feldspars from oligoclase to anorthite (*Cornéennes feldspathiques*). Marmorosis is common. On p. 48, M. Lacroix has given a clear statement of the theory of feldspathization and of the part played by the *agents minéralisateurs* in the recrystallization of metamorphic belts. As is well known, he is at one with MM. Fouqué, Michel Lévy, Barrois and others who contend for an actual migration of granite substance from an intrusive granite stock in the presence of mineralizing agents, into the country rock, as well as for the possible removal of certain elements in the exomorphic contact zone under the same conditions of intrusion. A detailed argument for this position is given in Chapter III; its analysis would be beyond the scope of this review.

It is particularly in the study of endomorphic contact action that the bulletin demands the attention of petrographers. While the slates do not seem to have exerted any very pronounced effect on the granite except in the way of slightly altering its structure, the limestone contact is one pronounced, both from the quality of the changes wrought and from their great areal extent, to be the most noteworthy phenomenon of the region. By the assimilation of the limestone, the granite successively loses the alkaline feldspars, orthoclase, microcline and anorthoclase, and lastly, quartz, and gains other constituents rich in lime, the basic plagioclases and hornblende. The result is to produce a gradual replacement of the pure granite magma in the massif by secondary mixtures which have crystallized out as hornblende-granitites, quartz-diorites, diorites, norites and hornblendites. Biotite and hornblende appear in the whole series. When, finally, olivine replaces all the feldspars, the resulting rock, though again the product of assimilation in the same way as the more acid rocks just enumerated, is an amphibole peridotite! The evidences for the fact of magmatic incorporation are exceptionally strong; they may be summarized as follows:

1. Field observations in connection with many localities of actual contact and the study of numerous thin sections showed ordinarily an insensible transition in mineralogical characters from the normal granite to the basic types.
2. These hornblende rocks are developed only in zones of contact between typical granite and the limestone, or else in bands which represent the prolongation of limestone layers stretching out into the granite—a significant mode of occurrence emphasized in the memoir. Such basic bands, extending through the granite from one end of an interrupted limestone layer along its strike to the corresponding end on the other side of the stock, are interpreted as being the product of recrystallization of mixed granite magma and digested limestone during a prolonged static condition of the igneous rock—that is, a period of quiescence as regards ascensional or lateral movement in the mass. It is hard to resist the conclusion that the map and numerous cross-sections of M. Lacroix prove such a long continuance of the limestone in contact with the particular magma now crystallized and visible where erosion has laid bare the zones of passage; and, moreover, that this fact explains the peculiarly favorable case for the proof of assimilation. The present reviewer is of opinion that the lack of

evidence for clearly defined endomorphic action leading to serious modification of eruptive magmas is, in many cases, due to a removal of the mixed zone of assimilation from contacts by bodily movement of the magma. Such a period of active assimilation and removal is followed by another of limited or no power of assimilation, during incipient cooling, and that stage by a third marked by the crystallization of essentially pure magma in contact with country rock, perhaps metamorphosed but not incorporated.

3. A striking argument for the modification of the granitite in this manner is afforded by certain inclusions within it, described as surrounded by the hornblendic basic types identical with those characterizing the main contacts.

4. No independent dikes, apophyses, or stocks of the basic rocks occur in the region, and on the right bank of the Oriège, at least, there is no dynamic action sufficiently intense to explain the presence of diorites, etc., in the granitite by any system of cross-faults.

5. Lastly, the absence of chilling phenomena in the stock, the intensity of the exomorphic metamorphism, the enormous number of apophyses in the slates, as well as other facts, all tend to show a condition of high temperatures for a long period, and of abundant mineralizers which are permissive of the large amount of recrystallization necessary to explain the occurrence of the basic rocks.

The mode of intrusion is implied in what precedes—a *mise en place* by progressive assimilation of the overlying terranes. The proofs of absorption of the quartzites and slates are not so strikingly manifest as those in the case of the limestone, but they are regarded by M. Lacroix as equally valid. On the other hand, neither block-faulting, nor the batholithic, nor the laccolithic hypothesis seems to be admissible.

On the whole, the memoir is seen to have its chief importance in upholding first, the doctrine of feldspathization of the metamorphic aureole about an intruded granite by the addition, in the presence of mineralizers, of feldspathic material from the granite's own mass; secondly, the doctrine of assimilation; and, lastly, the theory of the *mise en place* of intrusive granites, as enunciated by M. Michel Lévy. It is safe to say that, from the point of view of field observations and of comparative mineralogical study, these tenets of the French school of petrographers have never had in a single locality such strong confirmation. We shall look forward with interest to the forthcoming memoir

on the chemical relations of the rocks of this region. It may be that the analyses will explain certain difficulties which have suggested themselves, almost as a matter of course, in the way of explaining the formation of such minerals as hornblende and olivine (especially the latter) in the endomorphic zone of recrystallization. R. A. DALY.

RECENT BIBLIOGRAPHIES.

Bibliography and Index of North American Geology, Palæontology, Petrography, and Mineralogy for 1896. By F. B. WEEKS. (Bull. U. S. Geol. Surv., 149, 152 pp. Washington, 1897.)

Bibliografía Geológica y Minera de la República Mexicana. By R. AGUILAR y Santillán. (Bol. 10, Inst. Geol. de Mexico. 158 pp. Mexico, 1898.)

Students and workers in geology everywhere will be glad to receive the two papers here mentioned. The value of a well compiled and carefully edited bibliography is too well recognized to need any mention. To all active workers such books are indispensable. The two under review, fortunately, are both excellent. Mr. Week's good work in this line needs no introduction. It only remains to commend and to note the broadened scope of the bibliography. In its preparation 108 serials were examined, the number including several devoted to economic phases of geology and not previously listed. As usual the abstracts are concise, but are quite sufficient to determine the scope of the paper. The full indexes are especially valuable.

The bibliography of Mexico is especially helpful, because of the previous absence of any paper thoroughly covering the field. The author has had more than the usual difficulties, due to poor library facilities, the scattered and incidental nature of the papers, and the presence of broken sets of short lived serials. In the face of such materials there must necessarily be a certain amount of selection. Not all the papers listed are strictly geological but all will doubtless be helpful. At first glance the 1953 titles included seem formidable, and one is surprised at the amount which has been written, but a more careful examination shows, as remarked by the Director in his introduction, that the great majority of the papers written on the geology of Mexico are really technical engineering papers, and deal with geology